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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
08/825,360	03/28/1997	MARVIN LIAO	761/P7US/CVD	9780

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Patent Counsel Applied Materials, Inc.
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EXAMINER	
QUACH, TUAN N	
ART UNIT	**PAPER NUMBER**
2814	

DATE MAILED: 05/18/2004

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary	Application No.	Applicant(s)	
	08/825,360	LIAO ET AL.	
	Examin r	Art Unit	
	Tuan Quach	2814	

-- The MAILING DATE of this communication appears on th cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *01 March 2004*.

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *54-78 and 80* is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *54-78 and 80* is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☒ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☐ Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08) Paper No(s)/Mail Date _____.
4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____ .
5) ☐ Notice of Informal Patent Application (PTO-152)
6) ☐ Other: _____.

DETAILED ACTION

This application presents a claim for subject matter not originally claimed or embraced in the statement of the invention. The various additionally claimed matter regarding the collimator, e.g., claim 76, the ionization coil, e.g., claim 77, the particular material of tungsten as the first layer material, e.g., claim 69, 70. A supplemental oath or declaration is required under 37 CFR 1.67. The new oath or declaration must properly identify the application of which it is to form a part, preferably by application number and filing date in the body of the oath or declaration. See MPEP §§ 602.01 and 602.02.

The text of those sections of Title 35, U.S. Code not included in this action can be found in a prior Office action.

Claims 54-78, and 80 are rejected under 35 U.S.C. 103(a) as being unpatentable over Bai in view of Ho, Hower, or Fu, and Harshfield and/or Sandhu.

Bai (5,714,418) teaches forming substrate 40, forming dielectric 41, patterning the dielectric layer 40 to form trench 47, forming capturing layer 43 of titanium material having a thickness between 5 Å and 500 Å, forming blocking layer of titanium nitride having a thickness between 10 Å and 500 Å. Deposition by sputtering or by CVD is also taught. See column 5 lines 1-33, column 8 lines 7-57, Fig. 3, column 10, lines 4-49.

Bai lacks anticipation essentially in that it does not explicitly recite the plasma annealing of the titanium nitride barrier.

Ho (5,175,126) teaches plasma reaction of titanium nitride in suitable gases, e.g., oxygen, nitrogen, to fill the grain boundaries hence improving barrier characteristics.

See column 7 line 28 to column 8. The use of nitrogen or hydrogen as the gas to stuff the nitride is also taught. See column 7 lines 4-27, column 10 lines 3-20.

Hower (5,712,193) teaches plasma treatment of titanium nitride in argon to reduce silicon movement therethrough and to reduce interface defects. See column 2 line 56 to column 3 line 30.

Fu (5,685,960) teaches plasma treatment of titanium nitride in argon wherein the treatment smoothens the TiN and improves wettability. See column 2 line 48 to column 3 line 16.

Harshfield (5,612,558) teaches plasma annealing of refractory metal nitride 50 including by CVD using TDMAT having excellent conformity and the plasma annealing including in hydrogen or nitrogen is advantageous wherein organic content including carbon can be reduced and wherein lower resistance can be obtained. See column 4 line 29 to column 5 line 18. Note that the teachings in Harshfield referring to the annealing previously disclosed S.N. 08/336,260 which was filed Nov. 8, 1994, thus predates the July 6, 1995 date and that 08/336,260 corresponds to Sandhu 5,576,071 below.

Sandhu (5,576,071) (which corresponds to S.N. 08/336, 260) teaches chemical vapor deposition of refractory metal nitride having highly conformal layers even within deep contacts and other openings employing organometallic compounds, e.g., TDMAT and plasma annealing including hydrogen or nitrogen is advantageous wherein organic contect including carbon can be reduced and lower resistance can be obtained. See column 1 lines 16-367, column 3 line 64 to column 5 line 48.

It would have been obvious to one skilled in the art at the time the invention was made in practicing the Bai process to have employed plasma treatment of the titanium nitride since such is conventional and advantageous to improve barrier characteristics and wettability as taught by Ho, Hower, and Fu. The carbon reduction would take place during such plasma exposure since the same plasma processing is employed. Such annealing of the titanium nitride would have been further advantageous since it would permit the titanium nitride to have improved characteristics including lower resistance and reducing organic or carbon content as taught by Harshield and/or Sandhu. The use of organometallic precursor for deposition of titanium nitride is well known as evidenced by Harshfield and/or Sandhu. It would have been obvious and would have been within the purview of one skilled in the art to have employed conventional collimating sputtering including conventional use of ionization coil for such sputtering, to have selected the desired conventional plasmas, the conventional electrical biasing, and rf signal, to have employed conventional alternative refractory metal such as titanium, tungsten, tantalum, cobalt, molybdenum, and conventional alternative metal nitrides, including the optimization of appropriate layer thicknesses including the teachings as delineated in Bai as delineated above, including at column 10 lines 11-15, lines 48-50, lines 56-62. The plasma annealing in the same chamber or in a different chamber would have been obvious and would correspond to an obvious alternative wherein exposure to air and contamination therefrom can be avoided. Alternatively, official notice is given regarding such conventional collimating sputtering, conventional use of ionization coil during sputtering, conventional plasmas, electrical biasing and rf signal,

same chamber treatment, conventional alternative refractory metal or metal nitrides. The use of sputtering and CVD would have been conventional and obvious to form the layers in question and as such use of CVD of TiN including the use of metalorganic gas, e.g., as in claims 54, 65, 71, 79, 80 is advantageous to provide conformity as evidenced by Harshfield and/or Sandhu '071. Regarding the use of plasma of at least one gase of nitrogen, hydrogen, argon, helium, or ammonia, e.g., as in claims 58, 60, 67, the selection of such conventional and appropriate plasma would have been obvious given the plasmas employed in Ho, Hower, Fu, and Harshfield and/or Sandhu as delineated above.

Claims 58, 61-63, 66-67, 73 are rejected under 35 U.S.C. 103(a) as being unpatentable over Bai in view of Ho, Hower, or Fu, and Harshfield and/or Sandhu as applied to claims 54-78, 80 above, and further in view of Gilboa.

Regarding the limitations in these claims, Gilboa (EP 0 477 990) further evidences the conventionality of using appropriate plasma annealing ambient including ammonia, and the plasma treatment using the same chamber or a different chamber wherein exposure to air can be avoided, and the biasing during plasma treatment and the optimization of processing parameters to obtain optimal enhancement of a particular barrier film, see, e.g., column 4 line 33 to column 5 line 32.

It would have been further obvious to one skilled in the art to have employed such alternative plasma environment, alternative of using same chamber or different chamber, and the use of bias during plasma treatment since such use is conventional and advantageous as suggested by Gilboa.

Claims 54-78, and 80 are rejected under 35 U.S.C. 103(a) as being unpatentable over Dixit taken with Suguro and/or Sandhu '071 further in view of Ho and Fu.

Dixit (4,960,732) teaches forming channel 16 through insulating layer 14, forming titanium 19, e.g., about 100 Å, forming titanium nitride thereon, e.g., to about 250 Å, using conventional deposition method. Well known alternative refractory metals and metal nitrides and alternative deposition techniques are also shown. See column 4 line 64 to column 7 line 11. Dixit does not recite the plasma annealing and the reduced thickness of the titanium nitride.

The Suguro article teaches the use of TiN as barrier layer wherein optimization of layer thickness of the titanium nitride is also taught, including the use of TiN thickness of 4 nm, 7 nm, and 10 nm; see the abstract, the paragraph bridging pages 280 and 281, wherein TiN thickness as low as 10 nm is employed.

Harshfield (5,612,558) and Sandhu (5,576,071) are applied as above and teach forming refractory metal nitride including by CVD using TDMAT having excellent conformity and the plasma annealing including in hydrogen or nitrogen is advantageous wherein organic content including carbon can be reduced and wherein lower resistance can be obtained. See portions delineated above.

Ho and Fu are applied as above.

It would have been obvious to one skilled in the art at the time the invention was made in practicing Dixit to have employed plasma treatment of the titanium nitride since such is conventional and advantageous since it would permit the titanium nitride to have improved characteristics as delineated by Ho and Fu wherein any carbon removal

would have been inherent and obvious, and since such annealing would be advantageous to lower resistance and reduce organic or carbon content as taught by Harshield and/or Sandhu. It would have been obvious and would have been within the purview of one skilled in the art to have employed conventional collimating sputtering including conventional use of ionization coil for such sputtering, to have selected the desired conventional plasmas, the conventional electrical biasing, and rf signal, to have employed conventional alternative refractory metal such as titanium, tungsten, tantalum, cobalt, molybdenum, and conventional alternative metal nitrides, including the optimization of appropriate layer thicknesses including the teachings as delineated in Sugaro and Dixit as delineated above Alternatively, official notice is given regarding such conventional collimating sputtering, conventional use of ionization coil during sputtering, conventional plasmas, electrical biasing and rf signal, same chamber, conventional alternative refractory metal or metal nitrides. The use of sputtering and CVD would have been conventional and obvious to form the layers in question and as such use of CVD of TiN including the use of metalorganic gas, e.g., as in claims 54, 65, 71, 79, 80 is advantageous to provide conformity. Regarding the use of plasma of at least one gase of nitrogen, hydrogen, argon, helium, or ammonia, e.g., as in claims 58, 60, 67, the selection of such conventional and appropriate plasma would have been obvious as delineated above and as delineated in Sandhu above and in Fu evidencing the conventionality of appropriate plasmas. Alternatively, official notice is given regarding the selection of the desired and conventional plasmas. The use of first and

second plasma to insure effectiveness of such treatment would have been obvious as shown in Ho as delineated above.

Claims 58, 61-63, 66-67, 73 are rejected under 35 U.S.C. 103(a) as being unpatentable over Dixit taken with Suguro, Harshfield and/or Sandhu '071, and Ho or Fu as applied to claims 54-78, 80 above, and further in view of Gilboa.

Regarding the limitations in these claims, Gilboa (EP 0 477 990) further evidences the conventionality of using appropriate plasma annealing ambient including ammonia, and the plasma treatment using the same chamber or a different chamber wherein exposure to air can be avoided, and the biasing during plasma treatment and the optimization of processing parameters to obtain optimal enhancement of a particular barrier film, see, e.g., column 4 line 33 to column 5 line 32.

It would have been further obvious to one skilled in the art to have employed such alternative plasma environment, alternative of using same chamber or different chamber, and the use of bias during plasma treatment since such use is conventional and advantageous as suggested by Gilboa.

Claim 77 is rejected under 35 U.S.C. 103(a) as being unpatentable over Dixit taken with Suguro, Harshfield and/or Sandhu '071 and Ho or Fu as applied to claims 54-78, 80 above, and further in view of Kniseley.

The use of ionization coil for thin film coating as in this claim is well known in the art as delineated above and as evidenced by Kniseley, column 6 lines 54 to column 7 line 3 and as such would have been obvious.

The nonstatutory double patenting rejection is based on a judicially created doctrine grounded in public policy (a policy reflected in the statute) so as to prevent the

unjustified or improper timewise extension of the "right to exclude" granted by a patent and to prevent possible harassment by multiple assignees. See *In re Goodman*, 11 F.3d 1046, 29 USPQ2d 2010 (Fed. Cir. 1993); *In re Longi*, 759 F.2d 887, 225 USPQ 645 (Fed. Cir. 1985); *In re Van Ornum*, 686 F.2d 937, 214 USPQ 761 (CCPA 1982); *In re Vogel*, 422 F.2d 438, 164 USPQ 619 (CCPA 1970);and, *In re Thorington,* 418 F.2d 528, 163 USPQ 644 (CCPA 1969).

A timely filed terminal disclaimer in compliance with 37 CFR 1.321(c) may be used to overcome an actual or provisional rejection based on a nonstatutory double patenting ground provided the conflicting application or patent is shown to be commonly owned with this application. See 37 CFR 1.130(b).

Effective January 1, 1994, a registered attorney or agent of record may sign a terminal disclaimer. A terminal disclaimer signed by the assignee must fully comply with 37 CFR 3.73(b).

Claims 54-78, 80 are rejected under the judicially created doctrine of obviousness-type double patenting as being unpatentable over claims 1-41 of U.S. Patent No. 5,989,999 (hereinafter '999) in view of any of Dixit, Sandhu '382, or Suguro of record for the reasons of record.

Note that the terminal disclaimer has been disapproved since it is not signed by an attorney of record. The submission of a new terminal disclaimed signed by an attorney of record will be overcome this rejection.

Applicant's arguments filed March 1, 2004 have been fully considered but they are not persuasive.

Initially the 112 rejections have been withdrawn. The new declaration once filed will overcome the outstanding objection. Regarding the terminal disclaimer and the double patenting the filing of a terminal disclaimer signed by an attorney of record will overcome the double patenting rejection.

With regard to the July 6, 1995 date alleged by applicant, note that the teachings in Harshfield refers to 08/336,260, column 5 line 17, accordingly the titanium nitride by

organometallic deposition is known prior to the filing date of Harshfield, and is accorded the filing of 08/336,260 (November 8, 1994) thus predates the July 6, 1995 stated by applicant. See additionally Sandhu 5,612,558 which corresponds to said teachings.

Applicant argues that Ho, Fu, and Hower cannot be used to modify Bai. This however overlooks the advantages of plasma annealing as delineated wherein such plasma annealing of the titanium nitride is conventional and advantageous as delineated. Any carbon if present would be removed during such plasma annealing as the same annealing is employed. In addition, such carbon removal is well known as advantageous as evidenced by Harshfield and/or Sandhu. Applicant further objects to official notice but fails to specifically point out to any support for the inventiveness of various conventional and obvious alternative materials and processing, despite the specific teachings in the prior art evidencing the numerous materials and processing claimed corresponding to well know materials and processing.

Applicant further argues that the prior art do not teach the thickness less than 130 angstroms of the titanium nitride. Such layer thickness optimization however is well within the purview of one skilled in the art. Additionally, this overlooks the teachings of Suguro article teaching the use of TiN as barrier layer wherein optimization of layer thickness of the titanium nitride is also taught, including the use of TiN thickness of 4 nm, 7 nm, and 10 nm; see the abstract, the paragraph bridging pages 280 and 281, wherein TiN thickness as low as 10 nm is employed.

Applicant further argues that Gilboa does not teach titanium nitride deposited over titanium. This however overlooks the fact that Gilboa is applied in conjunction of

the previously delineated references wherein Gilboa evidences the conventionality of using appropriate plasma annealing ambient including ammonia, and the plasma treatment using the same chamber or a different chamber wherein exposure to air can be avoided, and the biasing during plasma treatment and the optimization of processing parameters to obtain optimal enhancement of a particular barrier film, see, e.g., column 4 line 33 to column 5 line 32.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to examiner Quach whose telephone number (571)272-1717. The examiner can normally be reached on M - F from 7 to 4.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor Wael Fahmy can be reached on (571)272-1705. The fax phone number for the organization where this application or proceeding is assigned is (703)872-9306.

Any inquiry of a general nature or relating to the status of this application or proceeding should be directed to the receptionist whose telephone number is (571)272-1562.

Quach

Tuan Quach
Primary Examiner